Aura Ozone and CO profiles retrieved from combined TES and MLS measurements

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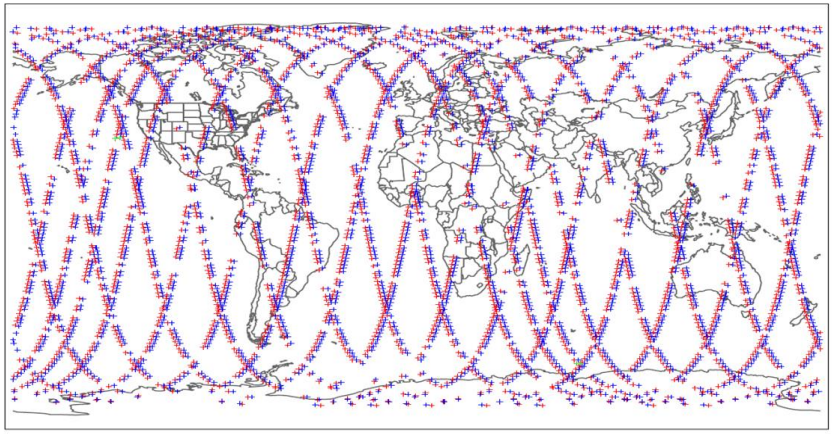
Jet Propulsion Laboratory
California Institute of Technology

Aura new joint retrieval products: CO and Ozone profiles

- Match good quality TES nadir and MLS limb at tangent observations closest in distance (50-200km) and time(~7 min).



- During TES L2 processing, store characteristic “intermediate” data terms. These data terms for MLS are calculated using “MLS Callable Forward Mode”.
- Combine TES and MLS spectral radiances, their instrument characteristic terms and a single a priori profile/constraint to retrieval the Aura CO and Ozone profiles.

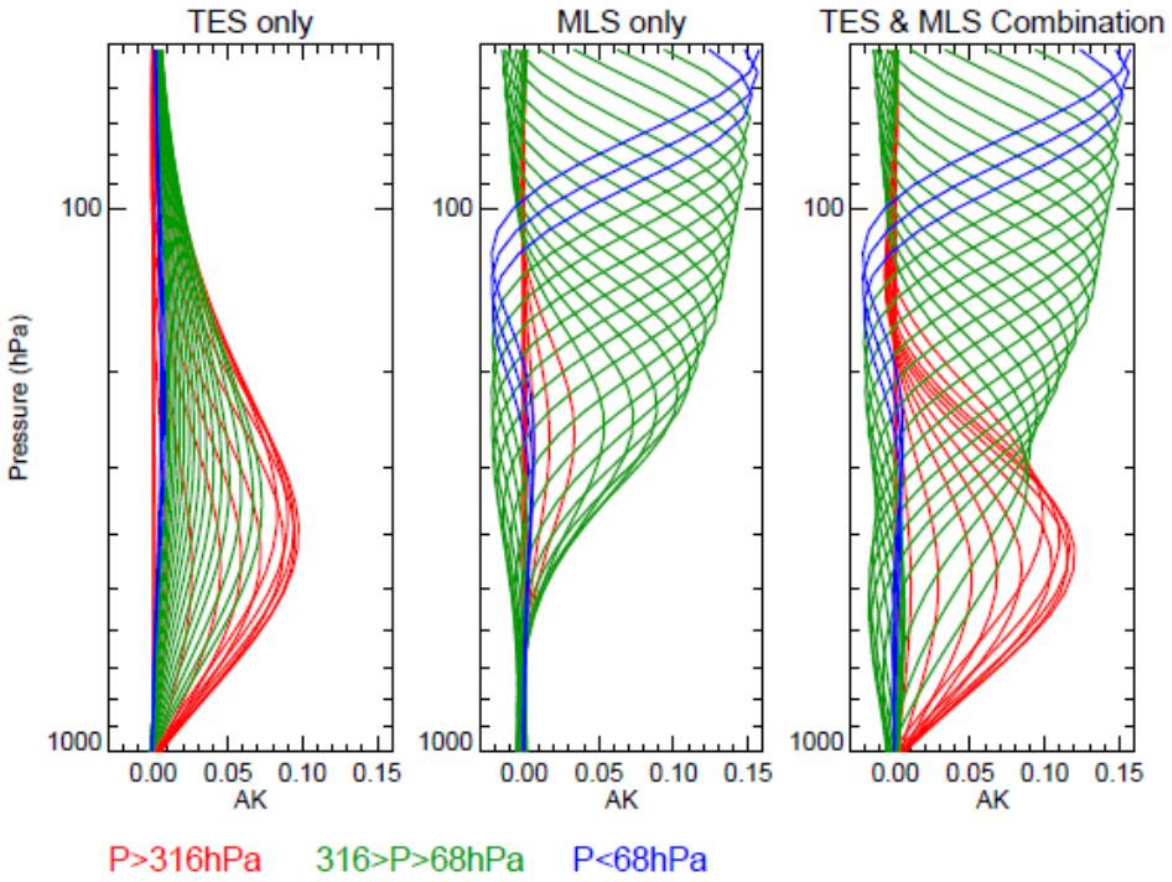
$$x^{i+1} = x^i + \hat{S}_t\left[K_{TES}^T S_{y\_TES}^{-1}\left(y_{TES} - FM_{TES}\left(x^i\right)\right) + K_{MLS}^T S_{y\_MLS}^{-1}\left(y_{MLS} - FM_{MLS}\left(x^i\right)\right) + S_a^{-1}\left(x_a - x^i\right)\right]$$

The total error and averaging kernel:

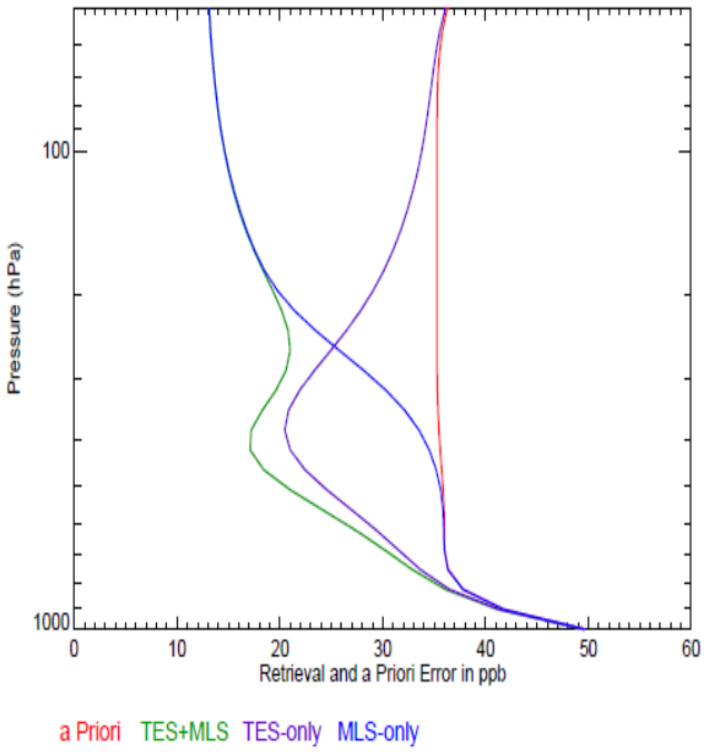
$$\hat{S}_t = \left({K_{TES}}^T {S_{y\_TES}}^{-1} K_{TES} + {K_{MLS}}^T {S_{y\_MLS}}^{-1} K_{MLS} + {S_a}^{-1}\right)^{-1}$$

$$A = \hat{S}_t\left({K_{TES}}^T {S_{y\_TES}}^{-1} K_{TES} + {K_{MLS}}^T {S_{y\_MLS}}^{-1} K_{MLS}\right)$$

Example of CO Averaging Kernels



Example of a Priori and retrieval errors



CO Degree of Freedom for Signal

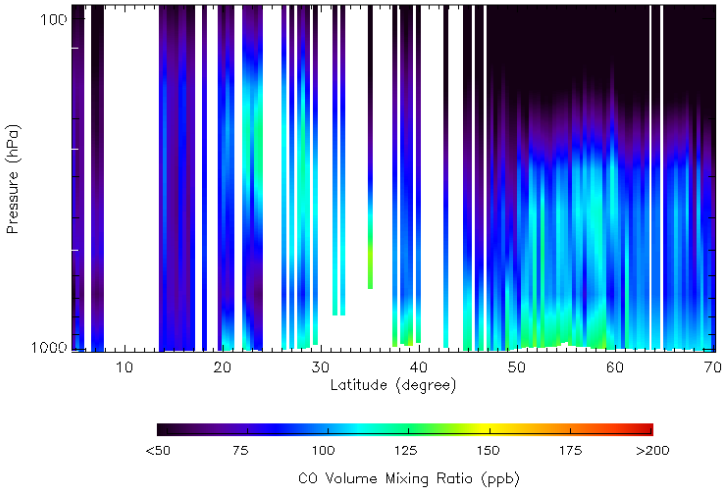
- TES-only: < 2
- TES-MLS combined (surface-50hPa): 2-4

O_3 Degree of Freedom for Signal (surface-50hPa)

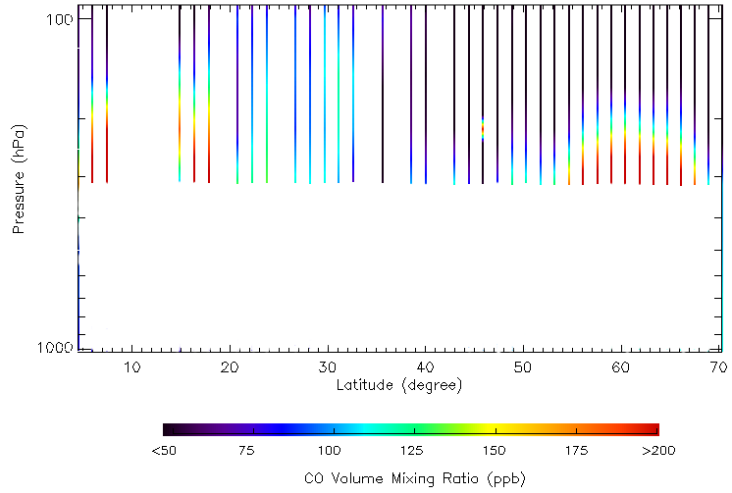
- TES-only: < 3
- TES-MLS combined: ~5

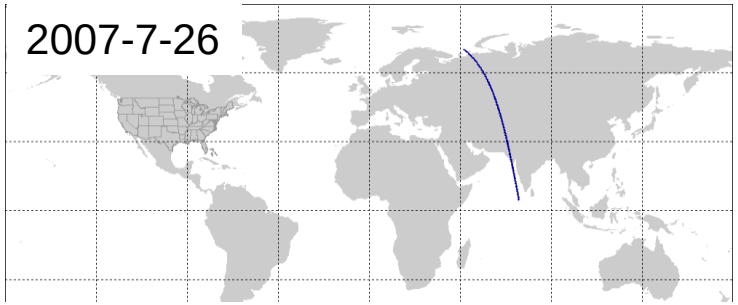
Example: TES Special Observation (Step & Stares)

TES CO

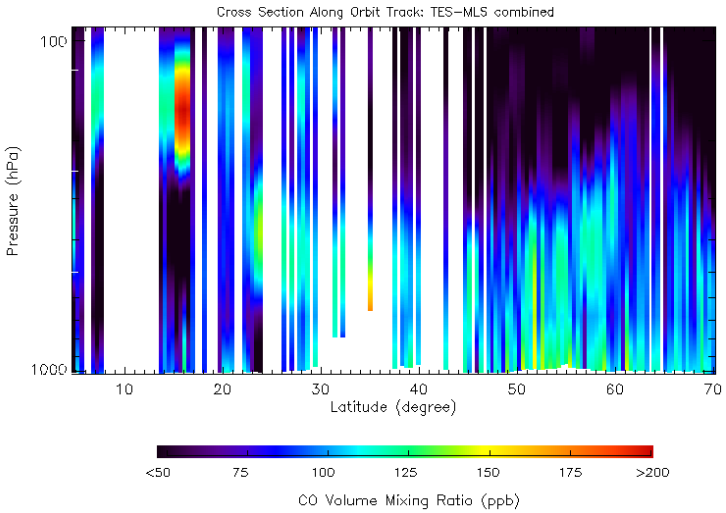


MLS CO



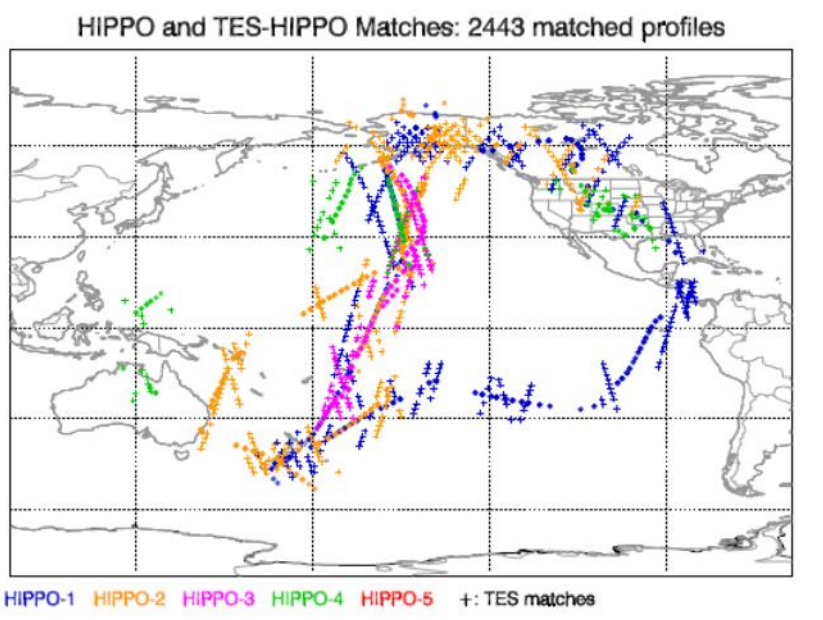


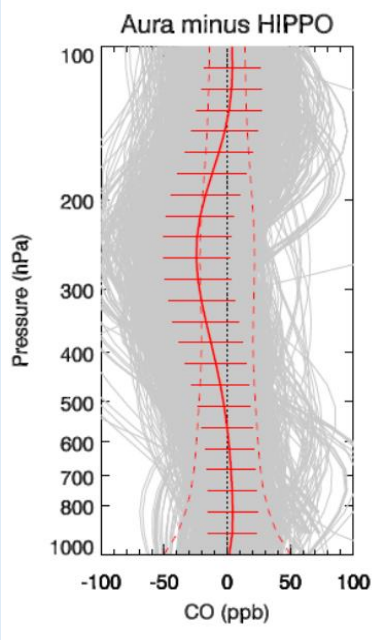
TES-MLS Combined CO



The MLS measurements contribute to the CO profile retrieval above ~316 hPa. In the lower-mid troposphere, Aura CO are very similar to TES CO distributions.

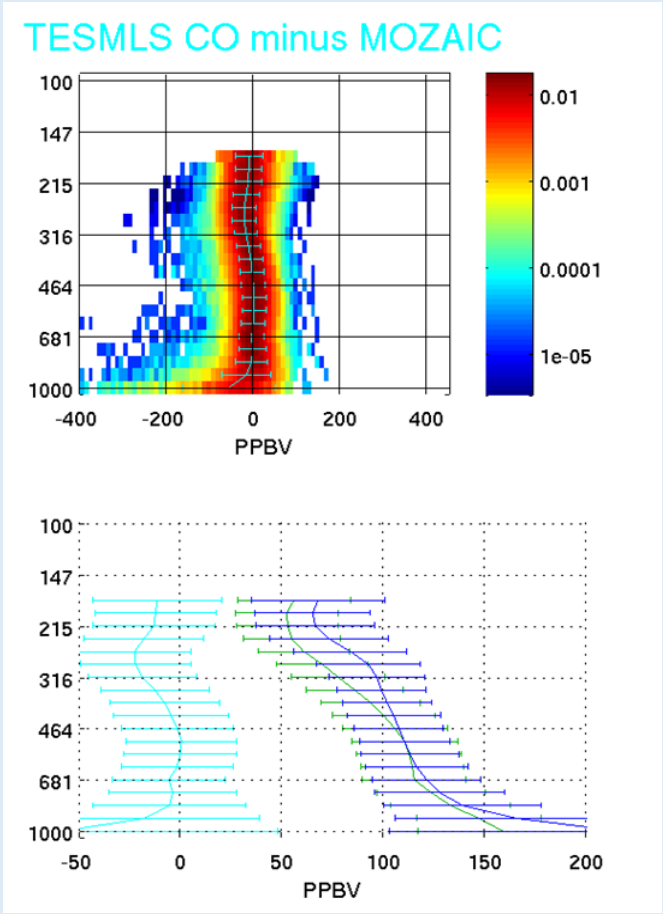
Aura CO Data Validation





Aura vs HIPPO:

Aura CO are 20-30% lower at 200-300 hPa



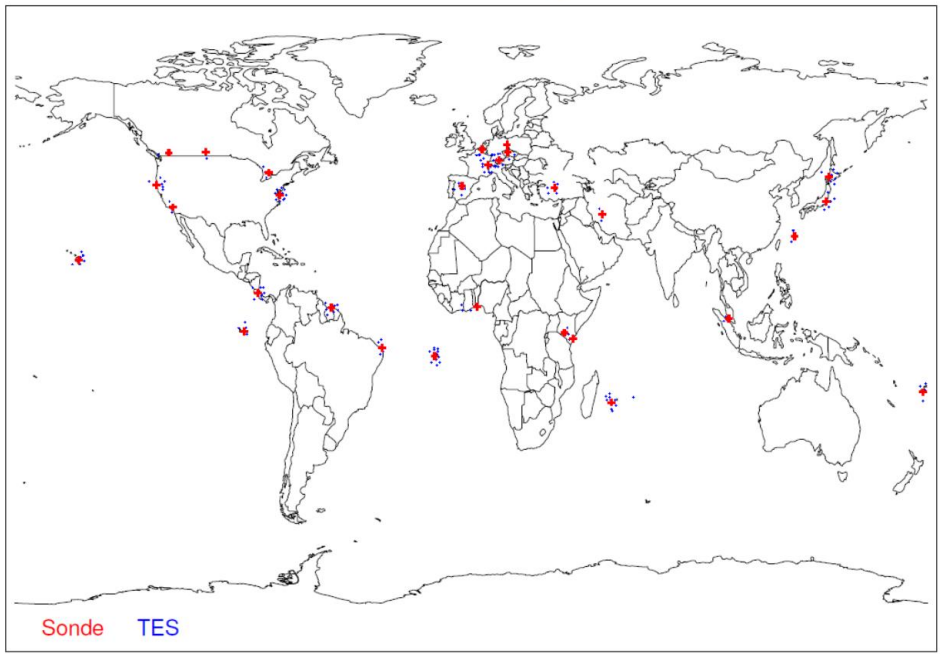
Aura vs MOZAIC:

Aura CO are 20-30% lower at 200-300 hPa

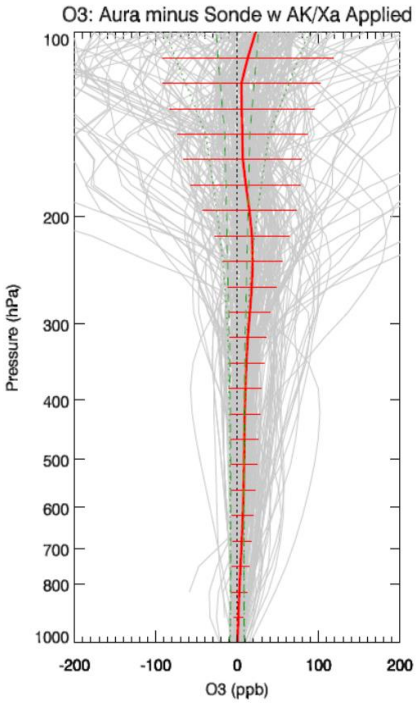
Expecting improvement in the new version data.

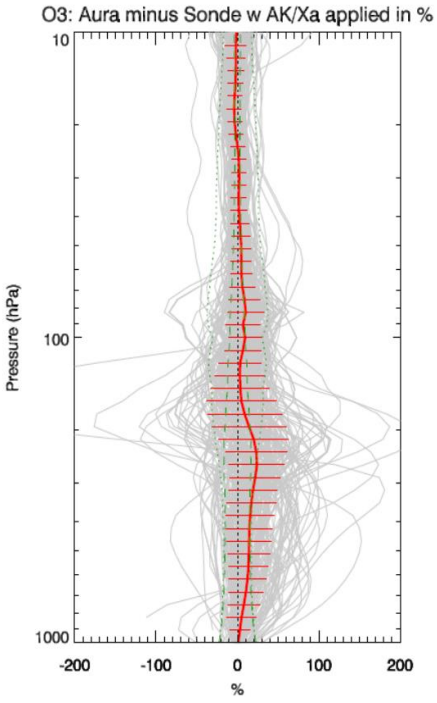
Aura Ozone Data Validation

TES footprints and sondes matches:
2006-2010, time diff < 9hr, distance < 300km



Comparisons between
Sonde adjusted by Aura Averaging Kernel / Xa and Aura O3 profiles





<u>Aura vs Sondes</u>:

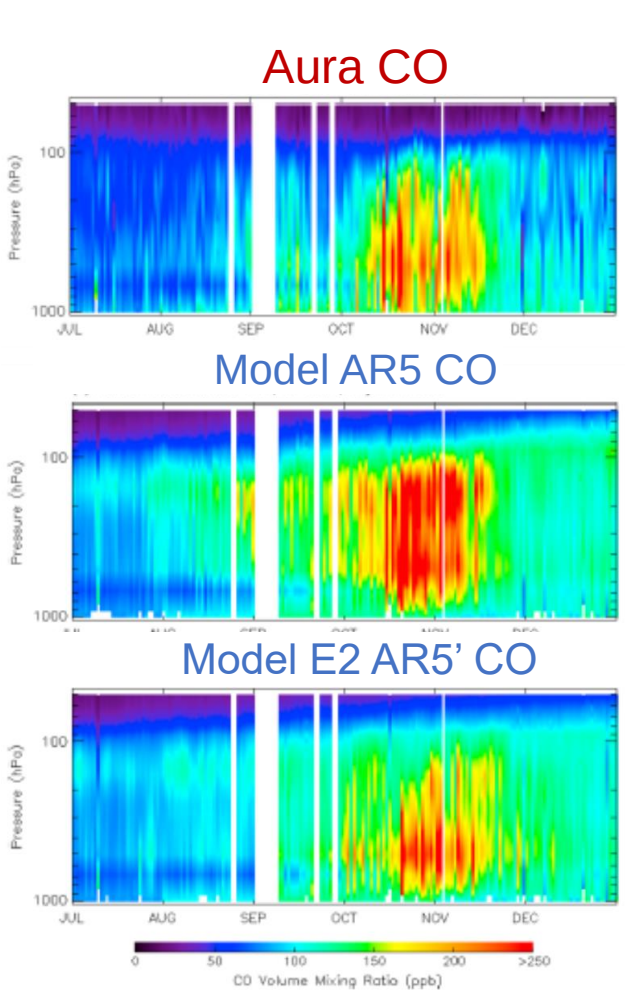
Aura Ozone are ~20% higher at 200-300 hPa

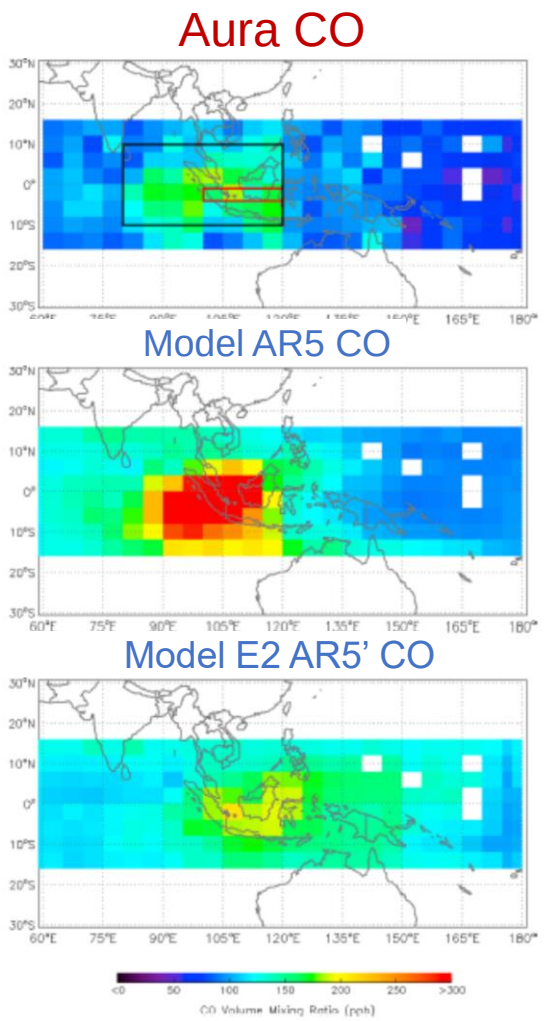
Aura CO data Applications

- Sensitivity of simulated tropospheric CO to subgrid physics parameterization: A case study of Indonesian biomass burning emissions in 2006

  Field R. *et al*., *J. Geophys. Res. Atmos.,* 2015.

Two configurations of ModelE2, one with the recent cumulus and turbulence parameterization changes to the NASA GISS ModelE2 (AR5') and one without the change (AR5), are used for an ensemble simulation of the transport of CO from the biomass burning. The simulation results are evaluated against the new Aura joint CO retrievals.



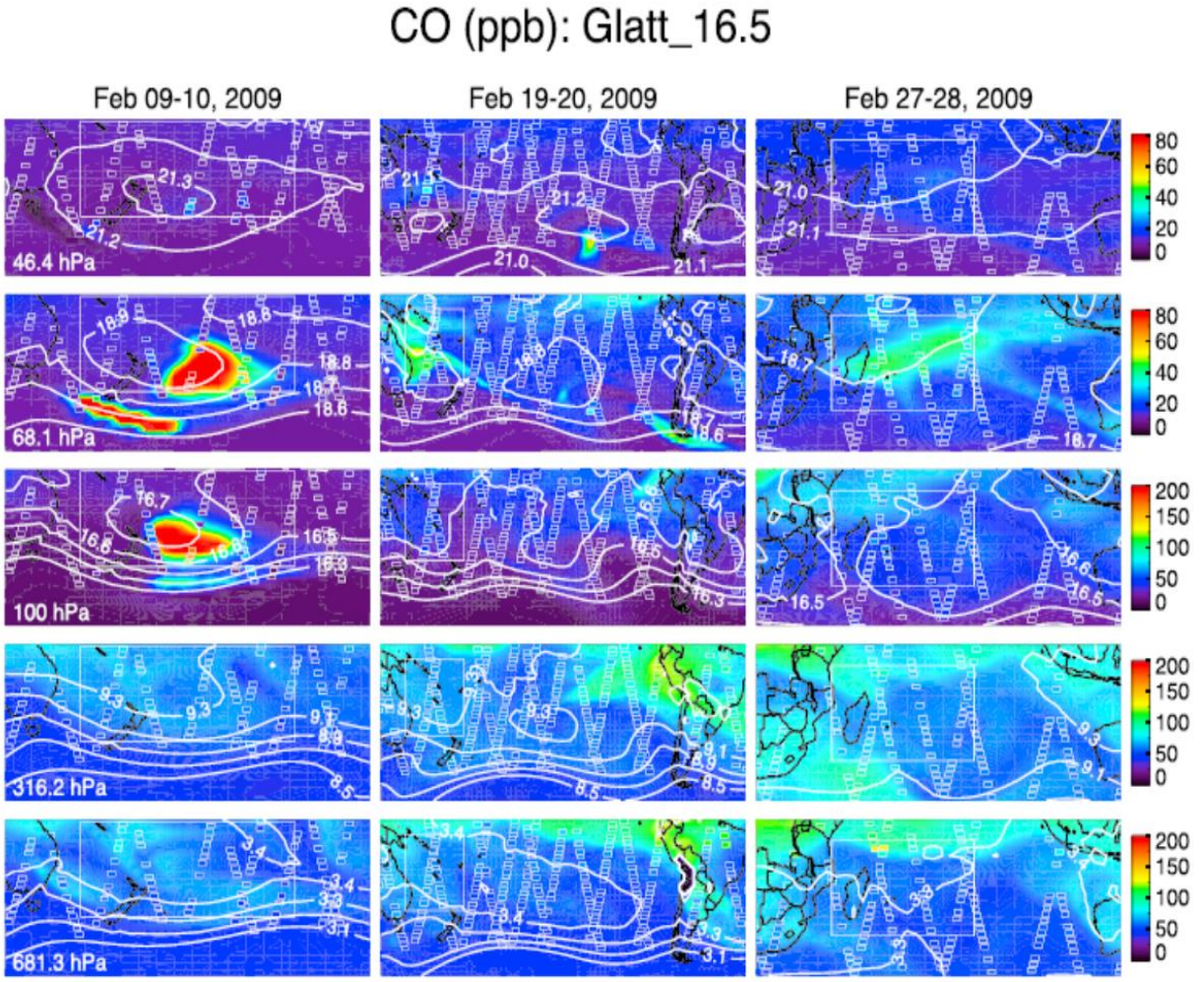


Aura CO data Applications

- Simulating the Black Saturday 2009 smoke plume with an interactive composition-climate model: sensitivity to emissions amount, timing and injection height

  Field, R. *et al*., *J. Geophys. Res. Atmos.,* 2016

To determine the sensitivity of the simulated smoke plumes to prescribed injection height, emissions amount, and emissions timing from different sources for the GISS ModelE2 when compared to Aura CO data.



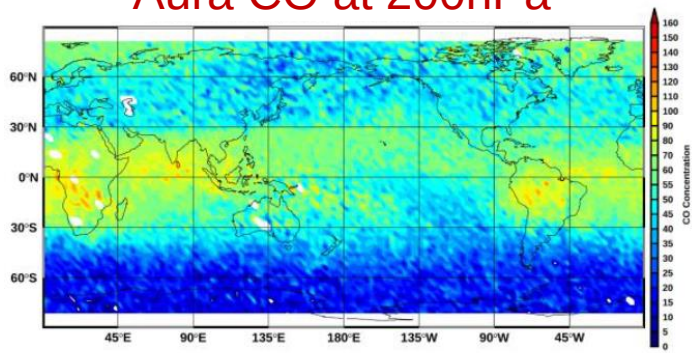
Aura CO data Applications

- Convective entrainment rates estimated from Aura CO and CloudSat/CALIPSO observations and comparison with GEOS-5

  Stanfield, R. et al., *J. Geophys. Res. Atmos.,* 2019

Using Aura CO and other satellite data to estimate entrainment rates in atmospheric convective parameterizations. Model comparisons are also performed.

Aura CO at 200hPa



GEOS-5 CO at 200hPa